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Conditions associated with unusual summer blooms of *Dinophysis acuta* in an upwelling area

Patricio A. Díaz[1], Beatriz Reguera[1], Isabel Bravo[1], Manuel Ruiz-Villarreal[2], Santiago Fraga[1]

[1]Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Vigo, Spain
[2]Instituto Español de Oceanografía, Centro Oceanográfico de A Coruña, A Coruña, Spain

Increased predictive capabilities of toxic microalgae outbreaks is a major objective of harmful algae experts from any region subject to their detrimental effects on aquaculture exploitations. In this context, one objective of the EU ASIMUTH project was "identification of key past events which will be re-analysed and used for training the modelling system". Here we re-analyze oceanographic data from cross-shelf transects sampled during 3 mini-cruises on September 13, 27 and October 11, 1990, before, during and after the autumn transition, and from weekly monitoring in Ría de Vigo and Ría de Pontevedra. Our objective was to parameterize shelf conditions associated with the onset, development and decline of an exceptional summer bloom of *D. acuta* occurring in late summer 1990.

Conclusions

- Persistent thermal stratification (1-2 months) combined with moderate upwelling during mid-late summer 1990 in the Galician shelf created the conditions for unusual summer blooms of *D. acuta*.
- Maximum cell densities of *D. acuta*, vertically segregated from *G. catenatum* maxima, were observed at the maximum thermal gradient.
- *D. acuta* was restricted to a narrow band of 20 km on the shelf (stations between 50-130 m isobaths).
- A 5-d time lag was observed between the quick onset (presumably resulting from long-shore transport) of *D. acuta* and *G. catenatum* cell maxima.

Introduction

Dinophysis acuta is an important producer of diarrhetic shellfish poisoning (DSP) toxins and pectenotoxins, which cause lengthy shellfish harvesting bans in European Atlantic coastal waters (Van Egmond et al. 1993). These shellfish closures are especially damaging in the Galician Rías (NW Spain), site of intense mussel aquaculture with an annual production of up to 300,000 t (Blanco et al. 2013). Usually, blooms (> 10^3 cell l^{-1}) of *D. acuta*in the Galician Rías Baixas are very seasonal (early autumn), appearing at the end of the upwelling season.

Material & Methods

The survey was carried out on board R.V. *Navarro* during three one-day cruises over shelf transects, which took place on September 13, 27 and October 11, 1990. Water samples for phytoplankton counts were collected with Niskin bottles. Vertical profiles of temperature, salinity, and pressure were obtained with a SeaBird SBE-19 CTD. In addition, Sippican XBTs were launched along a diagonal transect from Ría de Vigo to its adjacent shelf. Weekly samples for phytoplankton counts within the monitoring programme were collected at two stations located in Ría de Vigo and Ría de Pontevedra.

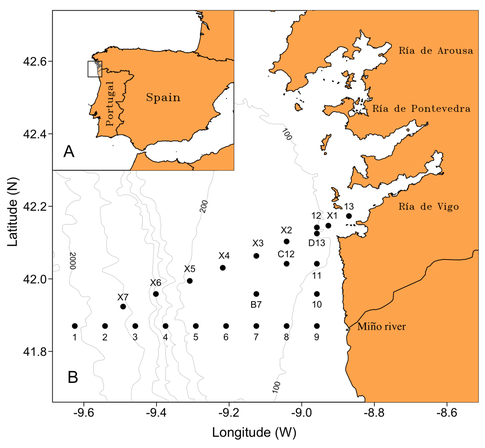

Fig. 1. The study area in the Galician Rías Baixas (NW Spain) and shelf stations visited during the cruises.

Results and Discussion

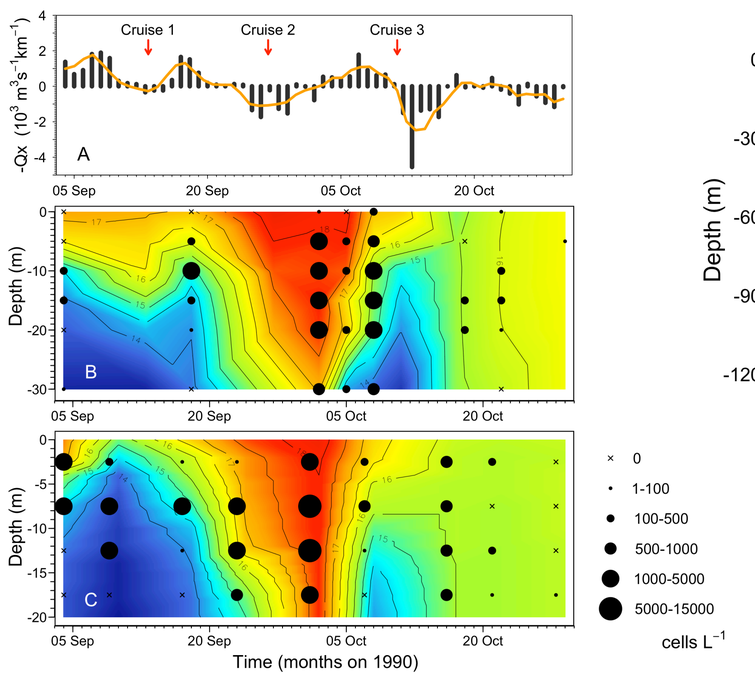

Fig. 2. Time series of upwelling index (upper), temperature and *D. acuta* cell densities recorded from 4 September to 31 October at Ría de Vigo (middle) and Ría de Pontevedra (lower) monitoring stations.

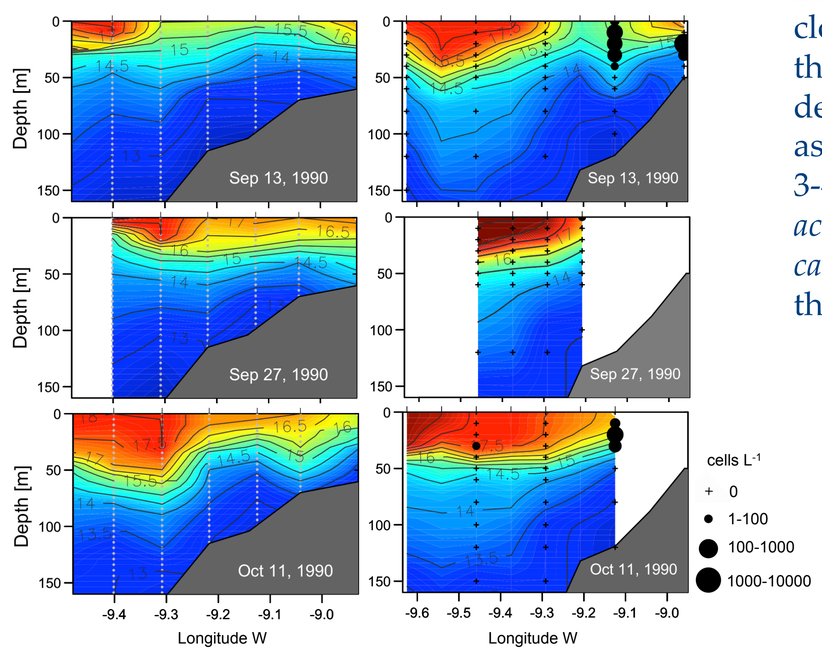

Fig. 3. Vertical distribution of temperature (ºC) through a diagonal (left) and perpendicular (right) transect on the Galician shelf during September 13, 27 and October 11, 1990. *D. acuta* cell densities are indicated in the left panel.

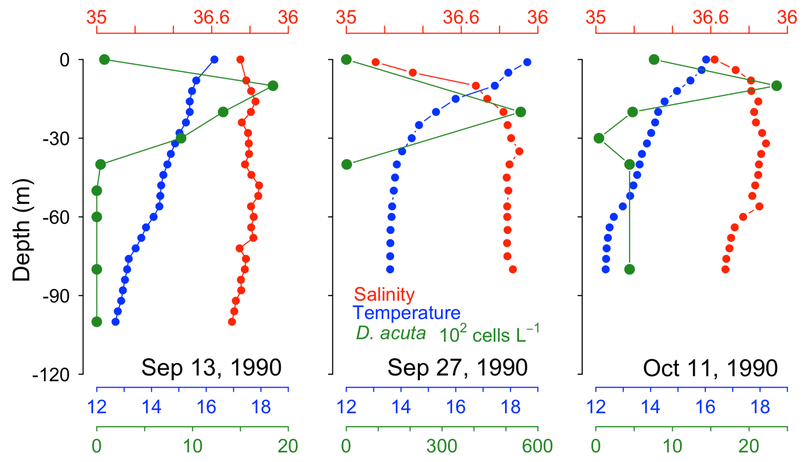

Fig. 4. Vertical profiles of salinity, temperature and *D. acuta* cell densities during the three one-day cruises at a shelf station.

During the first cruise (13 Sept.) there was an offshore Ekman transport generated by northerly winds (Fig.1). From 20 to 30 September there was a wind shift and southerlies became predominant resulting in onshore Ekman transport and a significant increase of temperature with maximum values close to 19°C at surface (Fig. 2). Results from the second mini-cruise (27 Sept.) showed a dense bloom of *D. acuta* with its maxima associated with strong thermal gradients (Figs. 3-4). In the outer Rías, the autumn peak of *D. acuta* was detected 5-d before that of *G. catenatum*, suggesting different distribution of the source populations.

Maximum cell densities ($5.4x10^4$ cells l^{-1}) were found at 20m (15.27 °C, 35.82 psu) on a shelf station off Ría de Vigo, with a vertical gradient of 0.2°C m^{-1} on the top 20m. Our results suggest that persistent thermal stratification combined with moderate upwelling during mid-late summer 1990 in the Galician shelf created conditions similar to those in the gravity centre (off Aveiro) of *D. acuta* populations further south in Portugal.

References

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Acknowledgments

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Presenter contact details: patricio.diaz@vi.ieo.es, Phone +34 986 492 111